Spin dynamics in the topological, low-symmetry $MoTe_2$ and WTe_2

Marc Vila[1]
Jose H. Garcia[1], Chuang-Han Hsu[2], L. Antonio Benítez[1], Xavier Waintal[3], Sergio O. Valenzuela[1,4], Vitor M. Pereira[5,6], Stephan Roche[1,4]

[1]Catalan Institute of Nanoscience and Nanotechnology (ICN2), CSIC and The Barcelona Institute of Science and Technology, Campus UAB, Bellaterra, 08193 Barcelona, Spain
[2] Department of Electrical and Computer Engineering, National University of Singapore, Singapore 117576, Singapore
[3] Université Grenoble Alpes, CEA, IRIG-PHELIQS, 38000 Grenoble, France
[4] ICREA–Institució Catalana de Recerca i Estudis Avançats, 08010 Barcelona, Spain
[5] Centre for Advanced 2D Materials and Graphene Research Centre, National University of Singapore, Singapore 117546
[6] Department of Materials Science and Engineering, National University of Singapore, Singapore 117575

marc.vila@icn2.cat

Recently, the low-symmetry phases ($1T_d$ and 1T') of transition metal dichalcogenides (TMDs) have attracted great attention for their spintronics potential and topological properties. In this talk, I will theoretically show unconventional forms of the spin Hall effect and the quantum spin Hall effect in monolayers of $MoTe_2$ and WTe_2. Due to the low crystal symmetry, the spin polarization of electrons in these TMDs displays a momentum invariant (persistent) spin texture fixed in a direction along the *yz* plane (Figure 1, left), and as a result, the spin transport displays anisotropic spin relaxation. The spin Hall effect exhibits an unconventional component, with spin accumulation generated in the plane, which together with the conventional out-of-plane polarization, forms an oblique or canted spin Hall effect. The spin relaxation length and the spin Hall angle are gate-tunable, being both maximum at the bottom of the conduction band, leading to a charge-to-spin interconversion figure of merit of 1-50 nm, largely superior to conventional spin Hall effect materials [1]. When the Fermi level is placed in the topologically nontrivial gap, the canted spin Hall effect is predicted to transition into a canted quantum spin Hall effect (Figure 1, right) [2]. The corresponding topologically protected edge states are robust to disorder and carry spins polarized in the same canted direction as the persistent spin texture found at the bottom of the conduction bands. Remarkably, these predictions have been recently confirmed experimentally [3]. Overall, our findings open new perspectives to predict and scrutinize spin transport in topological, low-symmetry two-dimensional materials.

REFERENCES

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FIGURES

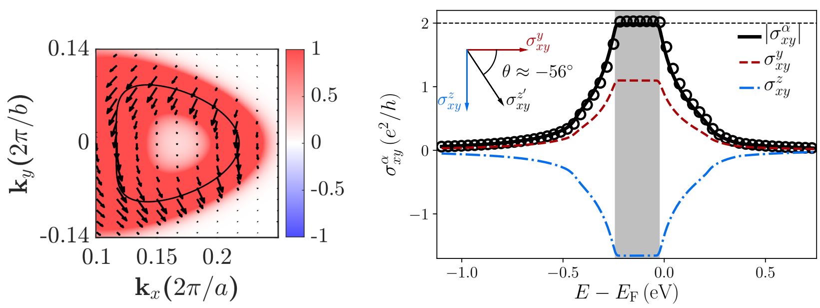

Figure 1: Left: Persistent spin texture in the *yz* plane of $MoTe_2$. Right: Spin Hall conductivity of WTe_2 displaying a canted quantum spin Hall effect.